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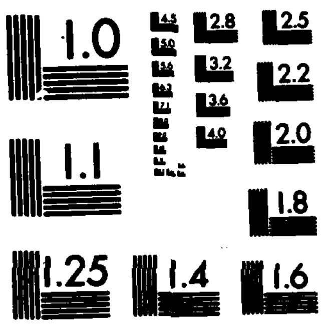

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METHODS OF CONTROLLING HUMIDITY IN WOODWORKING PLANTS[1]

By

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Operators of wood-processing plants in many parts of the United States experience production difficulties ascribable to swelling or shrinking of wood with seasonal changes in relative humidity. These difficulties, which may result in imperfect products, give rise to the problem of maintaining conditions in the shop and storage rooms that will hold such seasonal fluctuations to a minimum. Most commonly, the conditions arise in areas where buildings are heated during the winter, when the relative humidity is considerably lower inside the building than outdoors and, in consequence, the dry atmosphere of the shop causes the wood to dry and shrink excessively. Subsequent exposure of finished products to higher relative humidities results in swelling, warping, and other difficulties. To control such shop conditions, heated buildings require some sort of humidification equipment.

Throughout a large part of the United States, the moisture content of wood stored or used outdoors and protected from rain averages about 12 percent. In the drier areas of the Southwestern States the average moisture content of wood is about 8 or 9 percent. Coastal zones in the Southeastern States, in the Pacific Northwest and Southwest, and along the Gulf of Mexico, average slightly higher than 12 percent.

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[1] Slight revision of a report originally issued in 1958 under the same title as Forest Products Laboratory Report 1612.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

In most States, outdoor relative humidities during the summer are usually sufficiently high so that satisfactory conditions of equilibrium moisture content can be maintained indoors with adequate ventilation. When cool weather comes in the fall and buildings are heated, however, an important change takes place; lower relative humidities and lower equilibrium moisture content values are encountered. As the outdoor temperature decreases, the atmosphere can hold less and less water vapor per cubic foot than it could at higher temperatures. When heated to normal temperatures, without changing its water content, this outside air has a greater capacity for moisture and, since the relative humidity is the ratio of the quantity of moisture present in air to that which could be held at saturation under a given temperature it is correspondingly lowered. This causes drying of wood stored or housed in heated buildings and workrooms.

An illustration of the operation of this principle will be found by a study of table 1. Assume an average relative humidity of 75 percent for outdoor conditions and that no water is added to the inside space. This latter assumption, although not strictly true where people are working and manufacturing operations are in progress, is nevertheless sufficiently accurate to show approximately how conditions inside a building may change as outdoor conditions vary and why wood dries during the winter in a heated building.

To prevent the moisture content of material being processed from becoming too low, it is desirable to maintain a relative humidity of about 45 percent during the winter. This condition prevents the moisture content of the wood from falling below about 8 percent and introduces a less serious condensation problem than if a higher humidity were maintained. Condensation on windows and skylights can be minimized by double glazing, by heating the glass with steam coils, or by circulating warm air across the glass surfaces. By proper placement of humidifiers in woodworking plants, much can be gained in the reduction of condensation on windows, walls, and other cold surfaces. Drip from condensing surfaces should be prevented wherever it is likely to damage materials being processed.

New buildings in northern States can be designed with features that will readily avoid condensation, but in older buildings this cannot be done so easily. Windows of new buildings can be double glazed; or, for partial avoidance of condensation difficulties, glass blocks can be used. Insulation and moisture barriers can be installed in walls to prevent subsequent damage to the building. Such alterations can be made in existing buildings only with difficulty. There is less need for these special precautions, of course, if manufacturing plants are located in more moderate climates.

Methods of Humidity Control

As a rule, high relative humidity is not a problem in wood-processing plants in the northern part of the United States and, consequently, conditioning equipment is needed only to increase the humidity during the heating season. On the other hand, in manufacturing plants situated in very damp climates, such as prevail along the Gulf Coast, dehumidification may be required to prevent excessive humidity during prolonged periods of humid weather.

Air Conditioning

Where wood is to be stored so that a definite moisture content is maintained, a room inside a building, preferably with no exterior walls, floor, or roof and equipped with air-conditioning apparatus, can be used at any time during the year with satisfactory results. The apparatus and controls can be designed to meet particular needs.

For the conditioning of a large wood-using plant, any one of several methods may be employed. A central plant can be designed to condition the air completely and equipped with refrigeration or absorption apparatus as well as heating and humidifying facilities. The air is distributed by means of a system of ducts throughout the building. Such equipment is expensive.

Another method of conditioning the air in a plant completely is to install a number of small air-conditioning units throughout the plant and use no distributing system. These units, if fully equipped for year-round control, are likewise expensive and perhaps nonessential in most cases.

Heating

In localities where natural humidity is higher than necessary to give the required indoor condition, a definite moisture content in lumber awaiting use in storage buildings can be maintained by controlling the temperature of the space within the building by means of heaters controlled with a hygroscopic element. Such control is effective only as long as the natural humidity remains high. Even in humid localities indoor conditions may sometimes become too dry. If such conditions exist for any great length of time, devices can be installed to admit water vapor to the space.

Humidification

To accomplish humidification, as distinct from complete air conditioning, only relatively simple apparatus is needed. Steam jets may be distributed throughout the plant and controlled automatically by a moisture-sensitive instrument. The chief objection to the use of steam jets is that water is lost from the steam-generating plant and must be replaced. Another disadvantage is that heat is added to the space. In winter this may not be objectionable, but where humidification is required during a dry summer season, the heating effect of steam and the lack of evaporative cooling make this method unpopular. The simplicity of the steam-jet system and its freedom from dust residues commend it. But there is usually an odor with the discharge of steam and in some plants steam is not always available.

Another method of humidification is by the use of water at room temperature atomized by a jet of compressed air. With this simple method, water is discharged into the air as a finely divided mist. The slight noise that accompanies this spray generation is not usually objectionable in an industrial plant where there are machines operating. When properly designed humidifiers of this type are used, all issuing spray is evaporated without coarseness or drip. Furthermore, no heat is added to the air from such sprays. On the contrary, a marked cooling results from the evaporation.

Target sprays are also a possibility for this purpose. They discharge a fine stream of water against a plate. The bulk of the water striking the target is broken up into a fine mist that floats out into the room. Adequate filters must be provided to prevent plugging of the fine openings, together with a drain to remove drip.

A number of mechanical devices on the market operate with a rotating disk upon which water is allowed to flow. This disk rotates at high speed, so that the water is driven to the edge of the disk by centrifugal force and thrown against sharp metal teeth. The water is thus broken up into a fine mist and blown out into the room by a fan located behind the disk. Residues resulting from evaporation of the water accumulate on the apparatus and must be removed periodically. Usually, these evaporators are controlled with a hygroscopic element that opens or closes a water valve in the water feed line or starts or stops the humidifier motor. A number of them can, however, be controlled from a single humidistat.

Where water containing ~~qualities~~ quantities of organic substances or minerals is broken up into a mist by pneumatic, target, or mechanical humidifiers, small particles of dust are left suspended in the air and eventually settle. This is not usually objectionable in industrial plants where dusts are frequently generated by wood processing.

Humidifiers should not be located too close to the exhaust systems, because released moisture may be carried away before it effectively raises the relative humidity.

Table 1.--Effect of outside temperatures on inside relative humidity and equilibrium moisture content when the outside relative humidity is 75 percent

Outside temperature	Corresponding inside conditions at 72° F.	
	Relative humidity	Equilibrium moisture content
°F.	Percent	Percent
70	70.1	13.0
65	59.0	10.6
60	49.5	9.0
55	41.3	7.7
50	34.4	6.7
45	28.5	5.8
40	23.5	5.0
35	19.3	4.3
30	15.6	3.6
25	12.4	2.9
20	9.8	2.5
15	7.7	1.9
10	6.0	1.5
5	4.6	1.1
0	3.6	(1)
- 5	2.7	(1)
-10	2.1	(1)
-15	1.6	(1)
-20	1.2	(1)
-25	.9	(1)

[1] Less than 1.1.

Dehumidification

If dehumidification is a requirement, the space to be conditioned should be kept as small as possible and ventilation kept at a minimum. In some cases, it is possible to use drying agents, such as calcium chloride or silica gel, to maintain lower relative humidity, particularly if the space to be conditioned is small. Another alternative, previously referred to, is the use of heat to lower relative humidity.

Partial List of Manufacturers of Apparatus for Humidifying Factories

Armstrong Machine Works
8099 Maple
Three Rivers, Mich. 49093

American Moistering Company
P.O. Box 137
Cleveland, N.C. 27013

Bahnson Company
Bahnson Building
Winston-Salem, N.C. 27108

Carrier Air Conditioning Company
Carrier Building
Syracuse, N.Y. 13201

Parks-Cramer Company
444 Rose
Fitchburg, Mass. 01420

Research Products Corporation
1017 E. Washington Avenue
Madison, Wis. 53703

Spray Engineering Company
138 Cambridge Street
Burlington, Mass. 01803

Warren Components Corporation
1100 S. Irvine Street
Warren, Pa. 16365

This list has been prepared for the information of correspondents. The inclusion of names in the list implies no endorsement by the Forest Products Laboratory as to quality of service or cost.

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